Reacting mass problems 1

Worked example

5.40 g of aluminium reacts completely with oxygen. Calculate the mass of aluminium oxide formed in the reaction. Use these relative atomic masses: A_r of Al = 27, A_r of O = 16

What you do		What you get
Step 1	Write the balanced equation (if you are not already given it). Underline the substance with a given mass, and the substance you need to find.	$\underline{4Al} + 3O_2 \rightarrow 2\underline{Al_2O_3}$
Step 2	Calculate the relative masses of any underlined substance if it is not given to you.	M_r of $Al_2O_3 = (2 \times 27) + (3 \times 16)$ $= 102$
Step 3	Calculate the amount, in mol, of the substance for which you are given its mass, volume or concentration. This is aluminium here.	amount of Al $= \frac{5.40}{27}$ $= 0.2$ mol
Step 4	Work out the mole ratio between the underlined substances in the balanced equation.	4 mol of Al : 2 mol of Al_2O_3 Simplifies to 1 mol of Al : 0.5 mol of Al_2O_3
Step 5	Use your answers to steps 3 and 4 to calculate the amount, in mol, of the other substance.	0.2 mol of Al : 0.1 mol of Al_2O_3
Step 6	Use your answers to steps 2 and 5 to calculate the mass you are asked to find in the question.	mass of $Al_2O_3 = 0.1 \times 102$ $= 10.2$ g

Quick check

There is a way to check your answer quickly. You may be able to use this method instead of the one in the Worked Example – but check with your teacher first. Here is how it works for the question above.

$$\text{mass of } Al_2O_3 = \text{mass of Al} \times \frac{\text{total relative mass of } Al_2O_3}{\text{total relative mass of Al}} = 5.40 \times \frac{(2 \times 102)}{(4 \times 27)} = 10.2 \text{ g}$$

Questions

1. Carbon reacts with oxygen to form carbon dioxide: $C + O_2 \rightarrow CO_2$
   Calculate the mass of carbon dioxide formed when 24 g of carbon reacts completely with oxygen.

2. Magnesium reacts with oxygen to form magnesium oxide: $2Mg + O_2 \rightarrow 2MgO$
   Calculate the mass of magnesium formed if 6.0 g of magnesium reacts completely with oxygen.

3. Copper(II) oxide can be reduced by hydrogen: $CuO + H_2 \rightarrow Cu + H_2O$
   Calculate the maximum mass of copper that can be formed from 15.9 g of copper(II) oxide.

Use these relative atomic masses.

Element	H	C	O	Al	Mg	Cu
A_r	1	12	16	27	24	63.5

Reacting mass problems 1 – ANSWERS

1. Carbon reacts with oxygen to form carbon dioxide: $C + O_2 \rightarrow CO_2$

   Calculate the mass of carbon dioxide formed when 24 g of carbon reacts completely with oxygen.

   M_r of $CO_2 = 12 + (2 \times 16) = 44$

   amount of $C = \frac{24}{12} = 2$ mol

   Mole ratio C : CO_2 is 1 : 1

   This means that $2 \times 1 = 2$ mol of CO_2 forms

   Mass of CO_2 formed $= 2 \times 44 = 88$ g

2. Magnesium reacts with oxygen to form magnesium oxide: $2Mg + O_2 \rightarrow 2MgO$

   Calculate the mass of magnesium formed if 6.0 g of magnesium reacts completely with oxygen.

   M_r of $MgO = 24 + 16 = 40$

   amount of $Mg = \frac{6.0}{24} = 0.25$ mol

   Mole ratio Mg : MgO is 1 : 1

   This means that $0.25 \times 1 = 0.25$ mol of MgO forms

   Mass of MgO formed $= 0.25 \times 40 = 10$ g

3. Copper(II) oxide can be reduced by hydrogen: $CuO + H_2 \rightarrow Cu + H_2O$

   Calculate the maximum mass of copper that can be formed from 15.9 g of copper(II) oxide.

   M_r of $CuO = 63.5 + 16 = 79.5$

   amount of $CuO = \frac{15.9}{79.5} = 0.2$ mol

   Mole ratio CuO : Cu is 1 : 1

   This means that $0.2 \times 1 = 0.2$ mol of Cu forms

   Mass of Cu formed $= 0.2 \times 63.5 = 12.7$ g

Use these relative atomic masses.

Element	H	C	O	Al	Mg	Cu
A_r	1	12	16	27	24	63.5